[*INVESTIGATING, FORECASTING AND PROPOSING EMISSIONS-MITIGATION PATHWAYS FOR CO_2 EMISSIONS FROM FUEL COMBUSTION ONLY FOR UNITED STATES AND CANADA*]

[***Bismark Ameyaw**, School of Management and Economics, University of Electronic Science and Technology of China and Center for West African Studies, University of Electronic Science and Technology of China; No.2006, Xiyuan Ave, West Hi-Tech Zone, 611731, Chengdu, Sichuan, P.R. China., +8613693498270; 201714110101@std.uestc.edu.cn]

[**Professor Li Yao**, School of Management and Economics, University of Electronic Science and Technology of China, No. 2006, Xiyuan Ave, West Hi-Tech Zone, Chengdu 611731, Sichuan, China, +8613551008140, liyao@uestc.edu.cn]

[**Amos Oppong**, School of School of Management and Economics, University of Electronic Science and Technology of China; No.2006, Xiyuan Ave, West Hi-Tech Zone, 611731, Chengdu, Sichuan, P.R. China.; +8615608219396; oppong.amos@gmail.com]

[**Kingsley Nketia Acheampong**, School of Information and Software Engineering, University of Electronic Science and Technology of China; No.2006, Xiyuan Ave, West Hi-Tech Zone, 611731, Chengdu, Sichuan, P.R. China, +8618602866370; nketiakingsley@gmail.com]

Overview

The evolving nature of the Earth's climate can be very detrimental to life across the globe [1]. The first major challenge the world needs to tackle is carbon dioxide (CO_2) emissions. As CO_2 consist of a carbon atom, low carbon consumption is one of the strategies most economies are implementing [2]. Citizens in most economies are being admonished to switch to low carbon in order to prevent the dangerous effects of global warming from destroying the environment. The gradual shift from a carbon consuming economy to a low carbon consuming economy has caused major changes in the energy markets [3]. Countries like the United States of America (USA) and Canada have taken necessary measures to either combat, reduce to an appreciable level GHG emissions or are adamant to adhere to emissions mitigation target plans. A typical example of a country reviewing its Clean Power Plan (CPP) is the USA. Pursuant to the Paris Agreement, USA pledged to reduce GHG emissions to 26-28% from 2005 emission levels by 2025. Yet, USA involvement in the Paris Agreement remains uncertain as recent reports indicate that the USA has withdrawn from the agreement [4]. Likewise, Canada's Pan-Canadian Framework on Clean Growth and Climate announced in 2016, is an overarching strategy document for emission reductions containing proposals for economy-wide measures, including a carbon pricing plan as well as strategies to phase-out traditional coal plants. The regulation plans to phase out coal-fired power generation by 2030, reduce methane emissions from the oil and gas sector, phase down the use of hydrofluorocarbons (HFCs), continue to improve the emissions performance of vehicles, and introduce a clean fuel standard. Despite, all the efforts by the USA and Canada, literature has shown that recent policies enacted by the USA cannot either combat or reduce CO_2 emissions to an appreciable level [5]. Likewise, it has been asserted that Canada is likely to miss its Paris Agreement target to reduce economy-wide GHG emissions by 30% below 2005 levels by 2030 [6]. As most research works focus on forecasting total CO_2 emissions, it is yet unclear how mitigating the amount of CO_2 emissions from fuel combustion only (CEFFCO) can help in achieving the ultimate goal of sustainability. In filling this gap in literature, we provide readers the opportunity of knowing the impact of some macroeconomic variables on CEFFCO as well as forecasting the amount of CEFFCO and propose emissions-mitigation pathways for the USA and Canada to the year 2030.

Methods

Based on data uniformity, for our econometric analysis, we use Gross Fixed Capital Formation (GFCF) which is measured as a percentage of Gross Domestic Product (% of GDP), Total labor force (LF), Trade (TR) (% of GDP) and Gross Domestic Product per capita (GDPC) as our main determining variables for CEFFCO. This study employs the augmented Dickey-Fuller (ADF), Phillips-Perron (P-P), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests to detect the level of stationarity at $I(0), I(1)$, or $I(d)$. Based on the exclusivity, variability, volatility and lag-effect characteristics of our CEFFCO data, we use a data-driven modeling technique that is capable of checking and minimizing volatility requiring information to persist yet pivotal in the prediction-making process in Figure 1. In the algorithm formulation, we check the trends and seasonality in the datasets and fill the gap in literature by adding the holiday effects which may cause a shift in the amount of CEFFCO in our forecasting stage. The holiday effect introduced in the algorithm formulation cater for discretized events with a high surety of occurrence. We then propose CEFFCO emissions-mitigation pathways necessary to achieve long-term global climate goals.

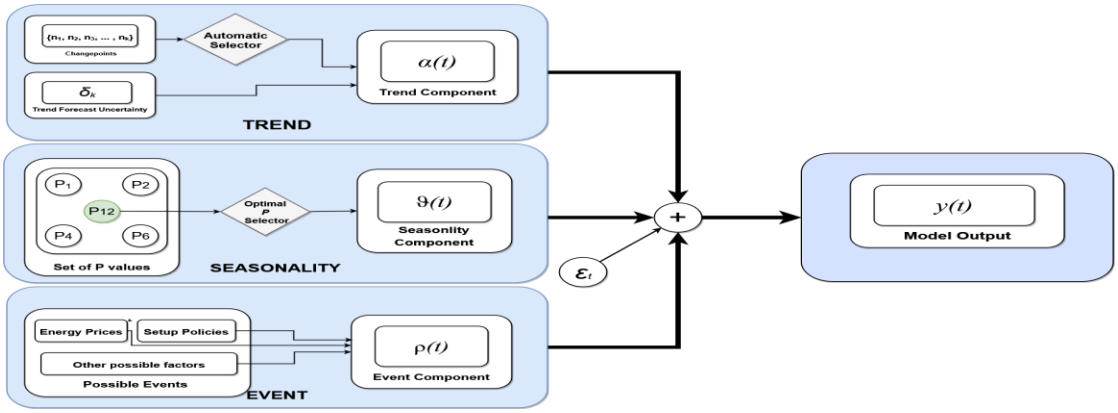

Figure 1: Summary of authors' methods in our algorithm formulation.

Results

On the macroeconomic relationship, for the case of the USA, unidirectional causality running from gross domestic product per capita to CEFFCO; total labor force to CEFFCO; trade to CEFFCO; and trade to gross domestic product per capita is found for the USA. For Canada, evidence of unidirectional causality running from gross domestic product per capita to CEFFCO; and from trade to gross domestic product per capita is found. For the forecasting phase, testing our algorithm against the realized values achieved MAD, MAPE and RMSE ~35.55 and RMSE of ~37.49 with MAPE accuracy of 99.28% for the USA and ~4.59, ~4.94 and ~99.15% for Canada. We forecast USA's CEFFCO for the year 2030 as ~877.46MtCO_2 and Canada's 2030 CEFFCO as ~321.34MtCO_2. For the emissions-mitigation pathways, our algorithm proposed that in order to achieve zero CEFFCO by 2030, the USA has to decrease CEFFCO from the current 2016 level of ~4833.08MtCO_2 to ~3391.41MtCO_2 and ~1716.18MtCO_2 by 2020 and 2025 respectively. Canada will have to decrease its 2016 emission level of ~540.77MtCO_2 to ~391.13MtCO_2 and ~205.63MtCO_2 by 2020 and 2025 respectively.

Conclusions

The findings from exploring the relationships among the econometric variables have important policy implications for the USA and Canada not only in terms of environmental perspective but offering the efficient allocation of resources for future decision making on CEFFCO. The strong dynamic co-integration results indicate that CEFFCO is increasing in the USA and Canada. Thus, if investments in clean energy are not instituted, these countries stand a risk of not meeting their Intended Nationally Determined Contributions (INDCs) in reducing greenhouse gas emissions. In order, to achieve zero CEFFCO by the year 2030, the USA and Canada, should both intensify and implement mitigation measures. Emission-mitigation measures should aim at promoting low carbon usage, penetrating and investing into the renewable energy sector, instituting a suitable and functional framework for climate change governance, scale up the adoption of efficient energy-saving technologies, and improving forest and solid waste management.

References

[1] Corfee-morlot J. Assessing the Impacts of Climate Change : A Literature Review Working Paper No . 691 OECD Econ Dep 2009; Working Paper. doi:10.1787/224864018517.

[2] Dong F, Hua Y, Yu B. Peak Carbon Emissions in China : Status, Key Factors, and Countermeasures — A Literature Review. Sustain 2018;10. doi:10.3390/su10082895.

[3] Daniel Gabaldon-Estevan, Elisa Penalvo-Lope DAS. The Spanish Turn against Renewable Energy Development. Sustainability 2018;10:1–16. doi:10.3390/su10041208.

[4] Rutherford TF. US Withdrawal from the Paris Agreement: Economic Implications of Carbon-Tariff Conflicts. Harvard Proj Clim Agreements 2017.

[5] Ramseur JL. U. S. Carbon Dioxide Emission Trends and the Role of the Clean Power Plan. Congr Res Serv 2017

[6] Canada's Climate Action Tracker 2017.